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CFO/Sponsored Projects Office

July 28, 1997

CALFED BAY-DELTA PROGRAM
1416 Ninth Street, Suite 1155
Sacramento, CA 95814

Attn: Ms. Kate Hansel

Phone: (916) 657-2666

Fax: (916) 654-9780

JUL 28 1997

REFERENCE REPLY: LBNL Proposal #BG97-286 (00)

Dear Ms. Hansel:

Enclosed for your consideration is an original copy of the subject proposal submitted on behalf of the E. O. Lawrence Berkeley National Laboratory (LBNL):

Title: Toxic Trace Element fluxes from Marsh, Mud Flat, and Shallow Subtitle Sediments: Determining the contribution of Fluxes from Sediments to Non-Point source Pollution in the Northern Reach of the San Francisco Bay

Principal Investigator: Angus McGrath and Peter Zawislanski

Total Amount Requested: \$803,012

Period Requested: 3 years from date of execution

Type of Request: New

Ernest Orlando Lawrence Berkeley National Laboratory is operated by The Regents of the University of California for the Department of Energy (DOE) under prime contract DE-AC03-76SF00098 and all work is conducted under the terms of that contract and subject to the approval of DOE. This proposal will be submitted to DOE for approval.

Should you decide to make an award, an interagency agreement for performance at LBNL should be sent to my attention consistent with the enclosed Administrative Instructions to Other Federal Agencies for Submission of Interagency Agreements for Reimbursable Work. I will coordinate final acceptance with DOE and return a fully-

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executed copy to your office.

Such agreement must include the following language:

"This agreement is entered into pursuant to the Authority of the Economy Act of 1932, as amended (31 U.S.C. 1535), and adheres to Federal Acquisition Regulation (FAR) 6.002 and other applicable Federal Laws and Regulations. To the best of our knowledge, the work requested will not place the DOE and its contractor in direct competition with the private sector."

This document is submitted in confidence prior to the completion of review for possible patentable inventions and subsequent filing of patent applications. Accordingly, this document is exempt from disclosure under the Freedom of Information Act under 5 USC 553(b)(3) & (b)(4) and implementing regulations, such as Executive Order 12,600 of June 23, 1987. Please do not make this document available to the public without permission.

If you have any questions regarding this submission, please feel free to call me on (510) 486-7324 or Facsimile No. (510) 486-4386. For technical matters, please call Peter Zawislanski at (510) 486-4157.

Sincerely,



Cole Cannon
Contracts Officer
CFO/Sponsored Projects Office
E-Mail Address: cbcannon@lbl.gov

Enclosures: SOW and Budget

cc: P. Zawislanski, w/o enclosures
A. McGrath, w/o enclosures
A. Bell, w/o enclosures
Chron
File

FK-302

ADMINISTRATIVE INSTRUCTIONS TO OTHER FEDERAL AGENCIES FOR SUBMISSION OF INTERAGENCY AGREEMENTS FOR REIMBURSABLE WORK

Funding documents submitted to the Ernest O. Lawrence Berkeley National Laboratory (LBNL) for acceptance by the Department of Energy (DOE) should be signed by an individual in the requesting agency authorized to approve interagency agreements (IA). DOE accepts the IA format of the requesting agency which is normally a funding document such as a Department of Defense Military Interdepartmental Purchase Request (MIPR) that cites a separate document such as a LBNL proposal in which specific work to be performed is stated.

The original funding document should be issued and sent to:

**U.S. Department of Energy
c/o Ernest O. Lawrence Berkeley National Laboratory
Sponsored Projects Office
Mail Stop 90-1070
Berkeley, CA 94720**

All LBNL activities, including work for other Federal agencies, shall comply with applicable environment, safety, and health (ES&H) statutes, regulations and standards. Accordingly, ES&H requirements shall be considered during the planning phase and adhered to during execution of Work for Others (WFO). Associated costs will be the responsibility of the requesting agency.

LBNL is not permitted to incur costs before funding is authorized or in excess of authorized funding. Therefore, please forward your IA as soon as possible so that we may obtain DOE acceptance and begin work.

Funding documents submitted to LBNL for acceptance by DOE must contain the following information:

1. For all Federal agencies, other than the Nuclear Regulatory Commission, a written statement is required stating that the requesting agency has determined that entering into an agreement with DOE for the use of LBNL is in compliance with the requirements of the Economy Act of 1932, as amended (31 USC 1535) or other applicable statutory authorizations. Those statutory authorizations must be cited. In addition, a written statement is required stating that the requesting agency has determined that entering into an agreement with DOE for the use of LBNL is in compliance with the Federal Acquisition Regulation (FAR) 6.002, and to the best of their knowledge, the work requested will not place DOE and LBNL in direct competition with the private sector.

Sample Statement from a Federal Agency

"This agreement is entered into pursuant to the authority of the Economy Act of 1932, as amended (31 USC 1535), or other statutory authority references and adheres to Federal Acquisition Regulation (FAR) 6.002. To the best of our knowledge, the work requested will not place the DOE and its contractor in direct competition with the private sector."

2. Cite the proper customer agency appropriation. State funds expiration date for obligations. Provide name, mailing address, and telephone number of the requesting office. Provide names

Ms. Kate Hansel

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and phone number of programmatic and financial points of contact. Provide billing information including office responsible for payment of bills.

3. Reference the LBNL proposal number and the title of the proposal. Provide funding document number of prior funding action if different than that being issued.
4. Cite reporting provisions as stated in the proposal as acceptable or state desired reporting requirements.
5. If the requesting agency plans on incremental funding, the reason full funding cannot be provided should be stated with a request for a DOE exception to DOE's full funding policy.

NOTE: DOE's policy is that work performed for other Federal agencies shall be fully funded for the current fiscal year plus the first three months of the following fiscal year for work that transcends fiscal years. Exceptions to the DOE full funding policy require approval by DOE prior to acceptance of the funding.

6. For construction or modifications to existing facilities which may be required as part of the project, the requesting agency shall include a request for construction and identify funding allocated for construction. DOE approvals associated with construction projects may take as long as three to six months to obtain. Title for permanent construction on DOE property will pass to DOE on completion of construction and acceptance by DOE.
7. If this is an award resulting from a response to a Broad Agency Announcement (BAA) or a similar type of solicitation the requesting agency must provide a written statement that the BAA is the only means used to acquire the work described in the BAA.
8. The requesting agency should provide any special instructions regarding disposition of property at the close of the project.
9. Additional information about DOE's Work for Others program can be accessed via the internet. The address is <http://www.hr.doe.gov/wfo/doe.htm#howto>. The document is titled *How Federal Agencies Obtain Technical Resources and Skills from the U.S. Department of Energy*.

10/14/96

I. Executive Summary

A. Title: Toxic Trace Element Fluxes from Marsh, Mudflat, and Shallow Subtidal Sediments: *Determining the Contribution of Fluxes from Sediments to Non-point Source Pollution in the Northern Reach of the San Francisco Bay*

Principal Investigators: Peter Zawislanski and Angus E. McGrath,
Earth Sciences Division,
E.O. Lawrence Berkeley National Laboratory,
MS-14-116, 1 Cyclotron Rd., Berkeley, CA 94720.
Phone: (510) 486-5970
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JUL 28 1997

RFP Project Group: Other Services

B. Project Description

The northern reach of the San Francisco Bay and the lower Sacramento and San Joaquin delta are significantly effected by outfalls of trace elements from five oil refineries, Mare Island shipyards, and the deposition of suspended sediments carrying contaminants from years of mercury and hydraulic gold mining in the coastal ranges and the Sierra foothills. Concentrations of heavy metals in plants, clams, mussels, and sediments from marshes, mudflats, and shallow/deep channels have been found to be extremely high within specific areas. Sediments, which include live and dead benthic organisms, represent a source of contamination through remobilization of the particles and transformation processes which result in the solubilization of toxic elements in porewaters. Takayanagi et al. (1990), Zawislanski and McGrath (in press) and various other researchers have demonstrated that trace elements are present in pore waters in concentrations that are greater than an order of magnitude higher than in overlying surface waters. This disparity creates a gradient which in combination with outward water flow generates a flux of trace elements. These fluxes can have a significant impact on trace element concentrations in benthic organisms feeding at the sediment/water interface. Fish and diving ducks feeding in shallow subtidal areas, mudflats, and wetlands are also effected directly by the trace element fluxes, or indirectly through feeding on benthic organisms that accumulate trace elements. No studies have been conducted to measure fluxes of trace elements from sediments in these three environments, and therefore their contribution as a Non-point source to trace element mobilization in the Bay needs to be determined.

We propose measuring the different forms of toxic trace elements in previously identified hotspots in the northern reach of the San Francisco Bay, to determine appropriate sites for subsequent measurements of toxic trace element fluxes from sediments in three different environments; marshes, mudflats, and shallow subtidal sediments. Elements will include As, Hg, Cd, Cr, Ni, Pb, and Se. Our objective is to provide Regulatory agencies, CALFED, and complimentary research studies with information about the role of dissolved contaminant fluxes from sediments in the overall budget of surface water concentrations and bioavailable forms of contaminants. Our study will be conducted in cooperation with a study by the US Fish and Wildlife Service, which will measure Hg, Se, and other trace element concentrations in duck species of varying dietary susceptibility to contaminated sediments and benthos. Other complimentary projects include a USGS proposal on deep channel concentrations of Hg and Se in sediments and impacted biota, the Regional Monitoring Program, the Federally funded USGS contribution to monitoring throughout the Bay, and the benthic flux measurements conducted by Dr. Kenneth Coale of Moss Landing Research Station, funded by an Office of Naval Research grant.

C. Approach/Tasks/Schedule

This project focuses on the measurement of contaminants into and out of sediments in the Northern Reach. Our emphasis will be on measuring physical and geochemical processes that control the mobilization of As, Hg, Cd, Cr, Ni, Pb, and Se into surface waters, and determine the chemical form released. We will conduct a three year field study at five locations in the Carquinez Strait, Suisun Bay, and Grizzly Bay. Laboratory experiments will be used to characterize the processes controlling chemical transformations in the sediments. The objective of this study is to determine the rates of release of toxic trace elements to surface waters in order to estimate their contribution to non-point source pollution in the Bay. Implementation of the project will be conducted through initial geochemical characterization of previously identified hot spots, including measurements of total sediment, water, and benthic organism concentrations of As, Hg, Cd, Cr, Ni, Pb, and Se, and determination of the dominant chemical forms of the most concentrated elements in waters and sediments. Measure the rates of accumulation and loss of toxic trace elements from sediments.

Field studies will focus on the production of toxic species which have been demonstrated to be the most bioavailable forms of contaminants (e.g. methyl mercury, amino acid selenium, uncomplexed or inorganically complexed metal cations such as Ni, Cd, etc.). Priority will be placed on identification of environments which are major sources or sinks of these toxic bioavailable forms of trace elements. Fluxes will be measured using benthic chambers in mudflats and shallow subtidal areas. Equipment will be developed for measurement of fluxes from sediments in marsh systems, where measurement of flow and porewater mobility is difficult to determine. We are aware of no other studies that have measured groundwater movement in a tidal marsh.

Laboratory studies will focus on determining the chemical mechanisms which control the high porewater concentrations Zawislanski and McGrath (in press) found in sediment porewaters of marshes and mudflats in the Carquinez Strait. We will also focus on the role of sediment organic matter in reducing Se and accumulating it in marsh surface sediments.

Project reports will be prepared on an annual basis outlining completion of tasks in each phase of the research. Year 3 will serve as the final report summarizing the projects accomplishment and presenting the implications of flux measurements for non-point source pollution. The final report will also outline the implications of the findings as it relates to the US Fish and Wildlife proposal put together by Dr. S. Schwarzbach et al.

D. Justification for Project and Funding by CALFED

To our knowledge, no other study has measured the flux of toxic trace elements out of marshes and mudflats in the San Francisco Bay. Dr. Kenneth Coale is currently measuring fluxes of nutrient trace elements and some toxic elements from sediments in shallow subtidal zones in the South Bay, and has plans to collaborate with our project and the USGS in the North Bay should funds be allocated. No studies have determined the rates of methyl-Hg and a variety of other trace elements from sediments, and these fluxes represent a significant threat to waterfowl, fish, and amphibian embryos. The impact of such fluxes will be determined by Dr. Steve Schwarzbach, who will focus on Clapper Rail eggs. Dr. Schwarzbach will measure failure to hatch rates and compare these to benthic organism Hg concentrations. Our flux measurements will be used to estimate methyl-Hg exposure rates for failed eggs.

Having accurate estimates of toxic trace element fluxes from sediments will allow water quality experts to determine safe effluent standards for point source dischargers, and allow for better modeling of toxic trace element accumulation in the Bay. Given the high concentration of toxic trace elements in sediment porewaters of the Carquinez marshes and mudflats, fluxes of toxic elements can be expected to be high long after point source discharge levels have been reduced. This represents an escalating problem of toxicity.

which needs to be addressed today, so that future water concentrations of contaminants do not escalate dramatically.

E. Budget Costs and Third Party Impacts:

This study will be jointly supported by the Department of Energy, and \$200,000 has been solicited for FY98. In addition collaborations with the US Fish and Wildlife Service will receive both agency funds and CALFED funding for completion of the Clapper Rail study proposed by Dr. Schwarzbach. CALFED funding is requested at the level of approximately \$250,000 per year for three years, for a three year total of \$750,000.

F. Applicant Qualifications:

Zawislanski and McGrath are currently completing a three year study of Se accumulation and speciation in the wetlands and mudflats of the Carquinez Strait. This research has identified many processes that control Se transformations in sediments and determined the role of suspended sediments in Se accumulation. Our research has mapped Se contamination in two affected wetlands and determined what forms of Se dominate in the sediments. We have developed specialized chemical extraction techniques to accurately assess the dominant chemical forms of Se and other trace elements in sediments. Dr. Satish Myneni, who will collaborate on this proposal, works with synchrotron radiation spectroscopic techniques involves ground breaking work which has provided the first elemental mapping of toxic trace element accumulation in bivalves of the Northern San Francisco Bay. These studies have also elucidated the mechanisms of sediment transformation of trace elements.

Our research group at LBNL has over ten years experience studying trace element geochemistry including work on mining wastes, agricultural drainage wastes (Kesterson), and oil refinery discharges.

G. Monitoring and Data Evaluation:

Our project will work in collaboration with monitoring programs such as the Regional Monitoring Program run out of the San Francisco Estuary Institute and the US Fish and Wildlife Services program monitoring Clapper Rail nest failure in northern reach of the San Francisco Bay. Since our project in itself is a characterization study to determine whether there is a need for monitoring simple quality assurance procedures, internal review of reports, and external review of published articles. Reports will provide significant interpretation beyond the data manipulations discussed in the project description.

H. Local Support/Coordination with other Programs/ Compatibility with CALFED Objectives:

This study will directly measure the health of marshes, mudflats, and shallow subtidal areas as habitat for benthic organisms and waterfowl. The fluxes measured will also have relevance to target fish species migrating through the Northern Reach of the San Francisco Bay. Many of these fish species feed on the benthic organisms which accumulate trace elements as a direct result of sediment-water exchanges of toxic trace elements.

Our project has the support of the SFB Regional Water Quality Board, US fish and Wildlife Service, the Regional Monitoring Program, and the Martinez and Southampton Bay regional park authorities. DOE is currently reviewing a proposal for funding on separate phases of this research.

CALFED objectives include examination of chemical contaminants on fish, migratory waterfowl, and wetland habitats and evaluation of water quality. This proposal clearly identifies stressors on waterfowl, fish, and wetland habitats, with important determination of previously unmeasured contaminant sources.

A. Title: Toxic Trace Element Fluxes from Marsh, Mudflat, and Shallow Subtidal Sediments: *Determining the Contribution of Fluxes from Sediments to Non-point Source Pollution in the Northern Reach of the San Francisco Bay*

B. Principal Investigators: Peter Zawislanski and Angus E. McGrath,
Earth Sciences Division,
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Phone: (510) 486-4157
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C. Organization: Federal Agency

D. Tax Identification Number and/or Contractor License: Not Applicable

E. Technical and Financial Contact Person:

Technical: Same as above

Financial: Cole B. Cannon

CFO/Sponsored Projects Office, E.O. Lawrence Berkeley National
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F. Participants/Collaborators in Implementation:

Dr. Satish Myneni will collaborate on laboratory studies of trace element transformations in porewaters and on sediment surfaces. Drs. Steve Schwarzbach and Kenneth Coale will collaborate with us in measurement of Hg and Se impact on Clapper Rail nest failures, and subtidal benthic fluxes respectively. Our proposal compliments research being conducted by Dr. Coale in the South Bay and USGS monitoring of deep channel benthic organisms, suspended sediments, and water concentrations in the North Bay.

G. RFP Project Group Type(s): Other Services

A. Project Description

Toxic trace element contaminations within certain areas of the Carquinez Strait has been attributed to local industrial sources. Five oil refineries discharge high concentrations of Se and lower concentrations of other heavy metals. Mare Island has high trace element concentrations from ship maintenance in shallow nearshore tidal areas. In combination with trace elements from the San Joaquin and Sacramento rivers, from both natural and anthropogenic sources, this region of the bay is significantly effected by toxic trace elements. Determining the rates at which trace elements accumulate and leach out of sediments is essential for determining environmentally sustainable discharge limits imposed on the industries within the northern reach of the Bay, based on Delta-North Bay budgets of trace elements. Most current models of trace element contamination mobility neglect to account for resolubilization and fluxes of elements back out of bottom sediments into surface waters. Measurement of these fluxes is essential to understanding the geochemistry of trace element cycling in estuarine and riverine systems, and especially for accurate assessment of the availability of contaminants to benthic organisms.

B. Location and/or Geographic Boundaries of Project:

The project will include wetland, mudflat and shallow subtidal areas in Carquinez Strait in Southampton Bay, Martinez Regional Park, Suisun Bay, Mare Island, and Grizzly Bay. Delta locations in the Sacramento and San Joaquin will be identified during initial characterization of potential sites.

C. Expected Benefits:

This study provides essential data for determination of water quality and sediment quality objectives so that regulatory standards for outfall from permitted dischargers of wastes. Thus regulatory standards can be set such that increasing contamination of the Bay is unlikely because regulators have realistic estimates of toxic trace element fluxes from both point and non-point sources. In addition, understanding the exposure rates of Clapper Rail nests in wetlands of the Carquinez Strait and the resulting nest failure rates will help managers of contaminated sites to restrict access to waterfowl and thus decrease the threat of such areas.

D. Background and Biological/Technical Justification

Zawislanski and McGrath (1997) have made the only measurements which have shown that porewaters from sediments of the Carquinez Strait contain elevated concentrations of toxic trace elements such as Se. Other researchers have found elevated concentrations of toxic trace elements in various estuaries worldwide raising questions concerning the importance of elevated sediment concentrations on surface water contamination (Takayanagi et al., 1990). Fluxes result because of high porewater concentrations overlain by surface water concentrations that are orders of magnitude lower. Even when the source of contamination that created elevated sediment concentrations has been removed or moderated, contaminated sediments will continue to release the trace element and contaminate the sediment-water interface. Contamination of porewaters and the sediment-water interface means that benthic organisms such as clams who constantly reside in a solution of high trace element concentration which influences tissue concentrations. The ability of these organisms to take-up and accumulate trace elements is species and trace element dependent.

Although the total loading of Se, or any other trace element, affects the overall health of an estuary, it is the interaction of different chemical forms (oxidation state and chemical association) of these trace elements with the suspended and underlying sediments which may have the most dramatic and immediate effect on the biological system. This is because some of the most important components of the food web are often found in the shallow sediment and tend to be filter feeders. Luoma et al. (1992) investigated Se uptake

by bivalves (*Macoma balthica*) and found that all particulate forms of Se were assimilated to some degree, with particulate organo-Se being assimilated with 86% efficiency and particulate Se(0) with 22% efficiency. They found that 98-99% of the Se found in *M. balthica* tissue came from particulate and not dissolved Se. In the case of metals, the opposite is true, and it is the dissolved concentration which is most important for biological uptake. Luoma et al. (1992) and other researchers emphasize the importance of not only measuring the total Se concentration of sediments, but also the chemical form and its association with the sediment.

In addition to affecting the biological uptake of a contaminant directly, elevated porewater concentrations alter the surface concentration of trace elements on suspended sediments in equilibrium with the more concentrated solution. As a result, organisms ingesting sediments resuspended from the surface will be exposed to a greater concentration of the contaminant. The interaction between dissolved and particulate forms of trace elements makes the determination of the flux of trace elements into or out of deposited sediments extremely difficult. Zawislanski and McGrath (1997) have estimated the sediment fluxes using sediment traps and evaluated the role of suspended sediments, surface water concentrations, plant material, and the degradation of organic matter on Se accumulation (see Table 1). This study was the most comprehensive study of Se cycling in wetland and mudflats of the northern reach. The proposed study will broaden the completed project to measure the outward fluxes of toxic trace elements including Se generated by water movement and elevated porewater concentrations.

Toxic Hot Spots in the Northern Reach of the San Francisco Bay

The Mussel Watch Program and regional monitoring programs have identified areas where high concentrations of various toxic trace elements accumulate in sediments, surface waters, and biota. Figure 1 shows where mussel data has been gathered over 12 years for the MWP, and Table 2 contains the average trace element concentrations for these sites. The mussel data does indicate that both resident and introduced organisms accumulate higher than normal trace element levels. Clam data generated by Luoma et al. (personal communication) reveals similar hot spots for Se in resident *M. balthica* and *Potamocorbula amurensis* clams within the northern reach of the Carquinez Strait, Suisun and Grizzly Bays. Concentrations ranged from 5 to 20 mg kg⁻¹ for Se and represent some of the highest accumulation rates seen for Se. Luoma et al. attribute the increase to greater bioaccumulation rates by *Potamocorbula*. The source of contamination in some of these areas is unclear, and much information can be gathered through a careful study of sediment and surface water concentrations and interactions. The current study should clarify the role of suspended sediments, bottom sediment, and porewater concentrations of toxic trace elements in benthic organism.

E. Proposed Scope of Work

The central focus of this study is to quantify the rate of transfer of trace elements between deposited sediments and the overlying surface waters in order to assess the contribution of toxic hotspots to contaminant concentrations in waters and sediments of the Northern Reach of the San Francisco Bay. As part of this study, processes which influence the trace element oxidation and reduction and are observed to occur in field samples, but are not clearly understood, will also be investigated. In collaboration with Dr. Steve Schwarzbach, we will measure methyl-Hg and methyl-Se (and other trace element) fluxes in the sediments surrounding failed Clapper Rail nests, to determine the relative role of toxic trace element contamination.

Experimental Design

Three zones will be investigated for their contribution to trace element fluxes in estuarine waters: marsh soils, mudflat sediments, and shallow subtidal sediments.

Emphasis in this study will be on determining the chemical form of a trace element that undergoes transformation and the relative concentration of each oxidation state of a specified trace element present. Many of the current monitoring programs fail to speciate trace elements in sediments and waters. Even though different chemical forms the same trace element can dramatically differ in toxicity. This study will require site assessment prior to flux measurements to determine the relative concentrations of different chemical forms of toxic trace elements.

Phase 1:

Based on data found in the MWP and RMP reports, sites in the Carquinez Straits, Suisun Bay, and the Delta will be selected for study based on trace element concentrations in sediment, water, or biota. This phase of the study has an expected duration of 6 months. Initial screening of sites will involve:

- Measurement water and sediment concentrations of target trace elements, and sediment water characteristics.
- Intensive characterization of the relative concentration of different chemical forms of each trace element.

Phase 2:

Once site characterization is complete, flux measurements will be determined using sedimentation apparatus and benthic chambers. Measurements will be conducted in dry and wet seasons within the marshes, to determine the effects of seasonal variations, as have been observed by Dr. Schwarzbach for January and April (with higher sediment methyl-Hg concentrations observed in April). This part of the study will also involve some laboratory experiments to determine how solution and sediment properties influence the rate of transformation, and fluxes of trace elements into or out of sediments. This phase of the study will have a duration of 2 years. Flux measurements and laboratory experiments will focus on:

- Subtidal flux measurements using benthic chambers.
- Flux measurements in the marsh areas will be conducted using equipment which is currently under design. The heterogeneity of this environment and tidal cycles make marsh measurements extremely difficult. The tool will be capable of gathering and preserving water and suspended particulate matter samples over a tidal cycle without changes in element chemical form. (Methyl-Hg and methyl-Se measurements will also be done in cooperation with Dr. Steve Schwarzbach of the US Fish and Wildlife Service, in sediments surrounding failed Clapper Rail nests).
- Laboratory experiments will focus on the role of organic matter, redox state, and mineralogy on speciation and mobility of trace elements in porewaters.

Phase 3:

The final phase of the study will involve development of a model which can adequately predict the flux of specific trace elements from sediments based on what will be identified as key parameters. The model will be tested against data collected as part of this project as well as data collected by others. The result will also be compared with data on trace element uptake by waterfowl, as collected by, among others, the US Fish and Wildlife Service. This will help identify factors which affect waterfowl uptake of trace elements and

the potential long-term exposures as a result of trace element remobilization from sediments.

F. Monitoring and Data Evaluation:

All aspects of this study will be published in peer reviewed journals, and all project reports are reviewed by two inside and two outside reviewers prior to release by LBNL. The data will be evaluated using a rigorous quality assurance program which our EPA certified analytical laboratory follows in its routine and specialized analyses. Our data will also be released to the San Francisco Estuary Institute for inclusion in the Regional Monitoring Program, where appropriate. This data will also be evaluated by the US Fish and Wildlife Service for inclusion in Dr. Steve Schwarzbach's proposal.

G. Implementation:

Access to two of the sites in this study have already been negotiated, and the proposed work is in compliance with all regulations and laws. Where required, permits will be sought, but no permits are required for the proposed research. Park officials at two of the identified sites, Martinez Regional Park and Southampton Bay (Benecia Regional Park) have pledged support for the project and provided access to idea locations for study. The SFB Regional Water Quality Board staff have supported the initial phases of this research, and are supportive of the ongoing effort.

IV. Costs and Schedule to Implement Proposed Project:

The proposed budget is outlined in the LBNL Proposed Budget Estimate tables. Phase completion dates are outlined in the project description and the proposed scope of work sections of the proposal.

V. Applicant Qualifications

The project will be managed by Peter Zawislanski and research will be conducted by Zawislanski (hydrological measurements and oversight), Dr. McGrath (field and laboratory Soil and Aquatic Chemistry measurements), and Dr. Myneni (Spectroscopic characterization of Soil and Aquatic Chemical reactions controlling trace element solubilization). Students and one technician (Steve Rodriguez) will be used for sample collection and processing. Analytical tests not conducted by the PI's and Steve Rodriguez will be run in the Environmental Measurements Lab (LBNL) by Scott Mountford (Masters level Analytical Chemist). Dr. Steve Schwarzbach will conduct a collaborating study on Clapper Rail nests within the identified study areas.

Biographical Sketches:

Mr. Peter Zawislanski

Peter Zawislanski received his Masters in Geology specializing in Hydrology from UC Berkeley. He has worked at LBNL for seven years studying Se contaminated sediments at the Kesterson Reservoir, vadose zone hydrology of and chemical speciation of organic contaminants at McClellan Airforce Base. He is currently principal investigator on the Bay Se project working with Dr. Angus McGrath on Se speciation in North Bay sediments in wetlands and mudflats. He has various publications on Se chemistry and hydrology, including the book chapter listed in Dr. McGrath's publication list.

Dr. Angus E. McGrath

Soil and Aquatic Chemist on a multidisciplinary project related to selenium contamination and cycling in the San Francisco Bay, CA. Responsible for workplan development, and design of field and laboratory activities, including sampling of water, sediments, algae, and plants, and refining analytical capabilities for trace metal quantification. Dr. McGrath has also worked on studies to determine the cause and remedial action required for plugging of rapid infiltration disposal beds for municipal waste discharges. Assessed impact of redox conditions, algal cell growth, and water table fluctuations on the permeability of treatment beds and proposed new treatment designs for a pilot study. In addition Dr. McGrath has worked as a review panel member for the review of the Metals Control Measures Plan for the Nonpoint Source Pollution Control Program of the Santa Clara Water District. Review remediation plans and effectiveness of proposed treatments.

Education

Ph.D. Soil Chemistry, University of California, Berkeley, 1994.
B.A. Chemistry, Hamilton College, Clinton, N.Y. 1985.

Honors

Provost Research Fund Grant, U. C. Berkeley, 1993-1994.
Carolyn Meek Fellowship, U. C. Berkeley, 1993-94.
Graduate Student Award in Environmental Chemistry; American Chemical Society, 1993.

Publications

Zawislanski, P.T., and A.E. McGrath. Selenium cycling in estuarine wetlands: Overview and new results from the San Francisco Bay. In *Environmental Chemistry of Selenium*. Eds. A. Frankenberger and R. Engberg. Marcel and Dekker, Inc., NY, NY. in press.
Moridis, G.J., P. Persoff, J. Apps. A. James, C. Oldenburg, A. E. McGrath, L. Myer, L. Pellerin, and K. Pruess. 1996. A design study for the isolation of the 281-3H retention basin at the Savannah River site using viscous liquid barrier technology. LBNL Annual Report. DOE, Nov. 1996.

- Zawislanski, P., A.E. McGrath, S. Benson, H.S. Mountford, T.M. Johnson, S.C.B. Myneni, S. Chau, E. Gabet. 1996. Selenium fractionation and cycling in the intertidal zone of the Carquinez Strait. LBNL Annual Report. DOE, Dec. 1996.
- Cheney, M., G. Sposito, A.E. McGrath, and R. Criddle. 1996. Degradation of 2,4-dichlorophenoxyacetic acid by birnessite catalysis. *Colloids and Surfaces A: Physicochemical and Engineering Aspects* 107: 131-140.
- Zawislanski, P., A.E. McGrath, S. Benson, H.S. Mountford, T.M. Johnson, L. Tsao, J. Oldfather, A.F. Haxo, and T.C. Sears. 1995. Selenium fractionation and cycling in the intertidal zone of the Carquinez strait. LBNL Annual Report. DOE, Nov. 1995.



Figure 1: Mussel Watch Stations Listed in Table 1

Table 1: Se concentrations in different plant defined zones of Martinez Regional Park marsh

Extracted Se Fraction	Sediment-Se concentration (% or as noted)			
	Distichlis/ Sarcocornia	Typha/ Sclirpus	Spartina	Mudflat
soluble	0.94	0.73	0.51	0.90
adsorbed	2.9	4.2	9.0	9.6
organically-assoc.	23	24	33	32
elemental	47	53	52	51
refractory	26	19	5.7	7.1
total-sediment (mg Se kg ⁻¹)	1.151	1.040	0.739	0.621
total-sediment (mg Se m ⁻²)	173	156	111	93.2
plant-shoots (mg Se m ⁻²)	0.155	0.420	0.118	none
plant-roots (mg Se m ⁻²)	11.3	2.42	0.482	none

Table 2: Mussel Watch Program data on toxic trace elements in the northern reach sites.

Location	Sampling Date	Ag	As	Cd	Cr	Cu mg kg ⁻¹	Hg	Ni	Pb	Se
Conc. NWS	88	0.132	nd	6.66	7.75	14.9	0.219	nd	1.74	nd
Selby S. 4	88	0.148	nd	14.2	4.47	12.5	0.263	nd	1.94	nd
Selby S. 5	88	0.103	nd	8.47	4.26	12.6	0.176	nd	3.07	nd
Selby S. 6	88	0.112	nd	11.4	5.08	11.5	0.217	nd	2.15	nd
Selby S. 7	88	0.165	nd	13.4	4.96	11.7	0.269	nd	1.86	nd
Mare Is.	85-89	0.129	nd	10.1	3.54	12.8	0.408	nd	2.53	nd
Davis Pt.	80,83,88	0.095	4.54	8.75	4.16	10.6	0.225	1.54	2.71	nd
Union Oil	88,89	0.955	nd	16.3	6.23	15.9	0.416	nd	3.07	32.4
Pt. Pinole	80-93	0.138	0.399	12.0	3.34	13.2	0.364	0.709	2.32	1.97
Castro C.	88,89	0.085	nd	7.1	3.71	11.8	0.598	nd	3.97	4.37

LBNL PROPOSAL BUDGET ESTIMATE

FY99 BG97-286

Project Title: Toxic Trace Element Fluxes from Marsh, Mud Flat, and Shallow Subtite Sediments: Determining

Budget Period: 10/01/97-09/30/00

PIs: Angus McGrath, Peter Zawislanski

		Effort [Effort unit]	Rate	Est Cost	Total Cost
A.	SALARIES AND WAGES				
	A.1 Zawislanski	3.00	5985	17,954	
	A.2 McGrath	3.50	5228	18,299	
	Myheri	1.00	4981	4,981	
	Mountford	2.00	5563	11,126	
	Rodriguez	3.50	3011	10,538	
	P9761	3.50	4944	17,304	
	P9730	4.00	1906	7,622	
	Seybold	2.00	3247	6,495	
	P9161	2.00	4635	9,270	
	TOTAL Labor	24.50			103,589
B.	FRINGE BENEFITS				
	B.1 Scientific/Career (A.1 divided by 1.20)	21.4%	95,987	17,114	
	B.2 Student	8.0%	7,622	610	
	TOTAL Fringe Benefits				17,724
C.	TOTAL SALARIES AND FRINGE BENEFITS				121,313
D.	SCIENTIFIC AND SUPPORT BURDEN				
	D.1 Scientific Burden (on C - A.X)	16.5%	121,313	20,017	
	D.2 Support Burden (on A.X)	0.0%		0	
	TOTAL Scientific/Support Burden				20,017
E.	SUBCONTRACTS, CONSULTANTS, & OTHER SERVICES				0
F.	PURCHASES				
	F.1 Equipment		0		
	F.2 Other procurements; lab & office supplies		20,000		
	F.3 Procurement burden/material handling		1,760		
	TOTAL Purchases				21,760
G.	TRAVEL				
	G.1 Domestic		7,000		
	G.2 Foreign		0		
	TOTAL Travel				7,000
H.	OTHER DIRECT COSTS - OVERHEADED				
	H.1 Publications		0		
	H.2 Central computing facilities		4,000		
	H.3 Recharges		4,000		
	H.4 Miscellaneous expenses		0		
	TOTAL Other Direct Costs, Overheaded				8,000
I.	OTHER DIRECT COSTS - NO OVERHEAD				
	I.1 Conferences and workshops		0		
	I.2 Stipends		0		
	I.3 Electricity		0		
	TOTAL Other Direct Costs, No Overhead				0
J.	OTHER BURDENS				
	J.1 Administrative recharges		0		
	J.2 ER-LTT Tech Transfer Burden (on C thru H)		0		
	TOTAL Other Burdens				0
K.	TOTAL DIRECT COSTS and BURDENS (C thru J)				178,090
L.	OVERHEAD				
	L.1 Site Support (on C + D + F.3 + H + J)	24.0%	171,090	41,062	
	L.2 G&A (on C+D+F.3+G+H+J+L.1)	21.0%	197,392	41,452	
	TOTAL Overhead				82,514
M.	TOTAL LABORATORY COSTS (K+L)				260,604
N.	DEPRECIATION (11.7% of C; 5.2% of H.2)				
O.	DOE-ADDED FACTOR (on Lines M+N)	4.3%			11,206
P.	TOTAL COSTS (M+N+O)				\$271,810

Date prepared: 7/28/97

LBLN PROPOSAL BUDGET ESTIMATE

FY99 BG97-288

Project Title: Toxic Trace Element Fluxes from Marsh, Mud Flat, and Shallow Subtropical Sediments: Determining

Budget Period: 10/01/97-09/30/00

PIs: Angus McGrath, Peter Zawislanski

		Effort [Effort unit]	Rate	Est Cost	Total Cost
A.	SALARIES AND WAGES				
	A.1 PI Zawislanski	6.00	6159	30,795	
	A.2 McGrath	5.00	5381	26,903	
	Myneni	1.00	5126	5,126	
	Mountainford	1.00	5725	5,725	
	Rodriguez	2.00	3099	6,197	
	P9761	2.00	5088	10,176	
	P9730	9.00	1961	17,649	
	Seybold	1.50	3342	5,013	
	P9181	1.00	4770	4,770	
	TOTAL Labor	27.50			112,354
B.	FRINGE BENEFITS		Rate	Base	Est Cost
	B.1 Scientific/Career (A.1 div 1.20)	21.8%	94,705	17,205	
	B.2 Student	8.0%	17,649	1,412	
	TOTAL Fringe Benefits				18,617
C.	TOTAL SALARIES AND FRINGE BENEFITS				130,971
D.	SCIENTIFIC AND SUPPORT BURDEN				
	D.1 Scientific Burden (on C - A.X)	16.5%	130,971	21,810	
	D.2 Support Burden (on A.X)	0.0%		0	
	TOTAL Scientific/Support Burden				21,810
E.	SUBCONTRACTS, CONSULTANTS, & OTHER SERVICES				0
F.	PURCHASES				
	F.1 Equipment			0	
	F.2 Other procurements: lab & office supplies		10,000		
	F.3 Procurement burden/material handling		880		
	TOTAL Purchases				10,880
G.	TRAVEL				
	G.1 Domestic		5,000		
	G.2 Foreign		0		
	TOTAL Travel				5,000
H.	OTHER DIRECT COSTS - OVERHEADED				
	H.1 Publications		0		
	H.2 Central computing facilities		3,000		
	H.3 Recharges		2,000		
	H.4 Miscellaneous expenses		0		
	TOTAL Other Direct Costs, Overheaded				5,000
I.	OTHER DIRECT COSTS - NO OVERHEAD				
	I.1 Conferences and workshops		0		
	I.2 Stipends		0		
	I.3 Electricity		0		
	TOTAL Other Direct Costs, No Overhead				0
J.	OTHER BURDENS				
	J.1 Administrative recharges		0		
	J.2 ER-LTT Tech Transfer Burden (on C thru H)		0		
	TOTAL Other Burdens				0
K.	TOTAL DIRECT COSTS and BURDENS (C thru J)				173,461
L.	OVERHEAD	Rate	Base	Est Cost	
	L.1 Site Support (on C + D + F.3 + H + J)	24.0%	168,461	40,431	
	L.2 G&A (on C+D+F.3+G+H+J+L.1)	21.0%	203,012	42,632	
	TOTAL Overhead				83,063
M.	TOTAL LABORATORY COSTS (K+L)				256,524
N.	DEPRECIATION (11.7% of C; 5.2% of H.2)				
O.	DOE-ADDED FACTOR (on Lines M+N)	4.3%			11,031
P.	TOTAL COSTS (M+N+O)				\$267,555

Date prepared: 7/28/97

LBNL PROPOSAL BUDGET ESTIMATE

FY00 BG97-286

Project Title: Toxic Trace Element Fluxes from Marsh, Mud Flat, and Shallow Subtitled Sediments: Determining

Budget Period: 10/01/97-09/30/00

PIs: Angus McGrath, Peter Zawislanski

		Effort			Total
		[Effort unit]	Rate	Est Cost	Cost
A.	SALARIES AND WAGES				
	A.1 PI: Zawislanski	4.50	6333	28,500	
	A.2 McGrath	4.50	5533	24,898	
	Myneni	0.00	5271	0	
	Mountford	1.00	5887	5,887	
	Rodriguez	3.00	3186	9,559	
	P9761	2.00	5232	10,464	
	P9730	6.90	2017	17,947	
	Seybold	1.50	3437	5,155	
	P9161	1.00	4905	4,905	
	TOTAL Labor	26.40			107,315
B.	FRINGE BENEFITS	Rate	Base	Est Cost	
	B.1 Scientific/Career (A.1 div 1.20)	22.2%	89,368	16,533	
	B.2 Student	8.0%	17,947	1,436	
	TOTAL Fringe Benefits				17,969
C.	TOTAL SALARIES AND FRINGE BENEFITS				125,284
D.	SCIENTIFIC AND SUPPORT BURDEN				
	D.1 Scientific Burden (on C - A.X)	16.5%	125,284	20,672	
	D.2 Support Burden (on A.X)	0.0%		0	
	TOTAL Scientific/Support Burden				20,672
E.	SUBCONTRACTS, CONSULTANTS, & OTHER SERVICES				0
F.	PURCHASES				
	F.1 Equipment		0		
	F.2 Other procurements, lab & office supplies		8,000		
	F.3 Procurement burden/material handling		704		
	TOTAL Purchases				8,704
G.	TRAVEL				
	G.1 Domestic		5,000		
	G.2 Foreign		0		
	TOTAL Travel				5,000
H.	OTHER DIRECT COSTS - OVERHEADED				
	H.1 Publications		0		
	H.2 Central computing facilities		7,000		
	H.3 Recharges		4,000		
	H.4 Miscellaneous expenses		0		
	TOTAL Other Direct Costs, Overheaded				11,000
I.	OTHER DIRECT COSTS - NO OVERHEAD				
	I.1 Conferences and workshops		0		
	I.2 Stipends		0		
	I.3 Electricity		0		
	TOTAL Other Direct Costs, No Overhead				0
J.	OTHER BURDENS				
	J.1 Administrative recharges		0		
	J.2 ER-LTT Tech Transfer Burden (on C thru H)		0		
	TOTAL Other Burdens				0
K.	TOTAL DIRECT COSTS and BURDENS (C thru J)				170,660
L.	OVERHEAD	Rate	Base	Est Cost	
	L.1 Site Support (on C + D + F.3 +	24.0%	165,660	39,758	
	L.2 G&A (on C+D+F.3+G+H+J+L.1)	21.0%	201,714	42,360	
	TOTAL Overhead				82,118
M.	TOTAL LABORATORY COSTS (K+L)				252,778
N.	DEPRECIATION (11.7% of C; 5.2% of H.2)				
O.	DOE-ADDED FACTOR (on Lines M+N	4.3%			10,869
P.	TOTAL COSTS (M+N+O)				\$263,647

Date prepared: 7/28/97

LBNL PROPOSAL BUDGET ESTIMATE
SUMMARY BG97-286

Project Title: Toxic Trace Element Fluxes from Marsh, Mud Flat, and Shallow Subtitled Sediments: Determining

Budget Period: 10/01/97-09/30/00

PIs: Angus McGrath, Peter Zawislanski

		Effort			Total
		[Effort unit]	Rate	Est Cost	Cost
A.	SALARIES AND WAGES				
	A.1 Zawislanski	12.50		77249	
	A.2 McGrath	13.00		70100	
	Myneni	2.00		10107	
	Mountford	4.00		22738	
	Rodriguez	8.50		26294	
	P9761	7.50		37944	
	P9730	21.90		43218	
	Seybold	5.00		16683	
	P9161	4.00		18945	
	TOTAL Labor	78.40			323,258
B.	FRINGE BENEFITS		Base	Est Cost	
	B.1 Scientific/Career (A.1 div 1.20)	varies		50652	
	B.2 GSRA	23.0%	0	3457	
				0	
	TOTAL Fringe Benefits				54,309
C.	TOTAL SALARIES AND FRINGE BENEFITS				377,567
D.	SCIENTIFIC AND SUPPORT BURDEN				
	D.1 Scientific Burden (on C - A.X)	16.5%	377,567	62,299	
	D.2 Support Burden (on A.X)	0.0%			
	TOTAL Scientific/Support Burden				62,299
E.	SUBCONTRACTS, CONSULTANTS, & OTHER SERVICES				0
F.	PURCHASES				
	F.1 Equipment		0		
	F.2 Other procurements; lab & office supplies		38,000		
	F.3 Procurement burden/material handling		3,344		
	TOTAL Purchases				41,344
G.	TRAVEL				
	G.1 Domestic		17,000		
	G.2 Foreign		0		
	TOTAL Travel				17,000
H.	OTHER DIRECT COSTS - OVERHEADED				
	H.1 Publications		0		
	H.2 Central computing facilities		14,000		
	H.3 Recharges		10,000		
	H.4 Miscellaneous expenses		0		
	TOTAL Other Direct Costs, Overheaded				24,000
I.	OTHER DIRECT COSTS - NO OVERHEAD				
	I.1 Conferences and workshops		0		
	I.2 Stipends		0		
	I.3 Electricity		0		
	TOTAL Other Direct Costs, No Overhead				0
J.	OTHER BURDENS				
	J.1 Administrative recharges		0		
	J.2 ER-LTT Tech Transfer Burden (on C thru H)		0		
	TOTAL Other Burdens				0
K.	TOTAL DIRECT COSTS and BURDENS (C thru J)				522,210
L.	OVERHEAD	Rate	Base	Est Cost	
	L.1 Site Support (on C + D + F.3 +	24.0%	505,210	121,251	
	L.2 G&A (on C+D+F.3+G+H+J+L.1)	21.0%	602,117	126,444	
	TOTAL Overhead				247,695
M.	TOTAL LABORATORY COSTS (K+L)				769,905
N.	DEPRECIATION (11.7% of C; 5.2% of H.2)				
O.	DOE-ADDED FACTOR (on Lines M+N	4.3%			33,106
P.	TOTAL COSTS (M+N+O)				\$803,011

Date prepared: 7/28/97

By Task Budget

SOURCE OF FUNDING		CALFED	CALFED	CALFED	CALFED	CALFED	TOTALS
		Year 1		Year 2	Year 3		
		Phase 1	Phase 2	Phase 2	Phase 2	Phase 3	
	Direct Labor Hours	2436	1827	4785	3132	1462	13642
Zawislanski	Hydrogeochemist	\$11,969	\$5,985	\$30,795	\$19,095	\$9,406	\$77,249
McGrath	Soil Chemist	\$10,430	\$7,869	\$26,903	\$16,682	\$8,216	\$70,100
Myneni	Soil Chemist	\$4,981	\$0	\$5,126	\$0	\$0	\$10,107
Mountford	Analytical Chemist	\$5,563	\$5,563	\$5,725	\$5,887	\$0	\$22,738
Rodriguez	Technician	\$6,007	\$4,531	\$6,197	\$6,404	\$3,155	\$26,294
Wong	Analytical Tech	\$9,863	\$7,441	\$10,176	\$10,464	\$0	\$37,944
Student	Student Tech	\$3,811	\$3,811	\$17,649	\$10,050	\$7,897	\$43,218
Seybold	Secretarial Support	\$3,247	\$3,248	\$5,013	\$3,454	\$1,701	\$16,663
Shops	Technician	\$4,635	\$4,635	\$4,770	\$4,905	\$0	\$18,945
Benefits		\$9,100	\$8,624	\$18,617	\$5,390	\$12,579	\$54,310
Direct Salary and Benefits		\$69,606	\$51,707	\$130,971	\$82,331	\$42,953	\$377,568
Computing/Telephone		\$4,000	\$4,000	\$5,000	\$4,000	\$7,000	\$24,000
Supplies		\$10,000	\$10,000	\$10,000	\$5,000	\$3,000	\$38,000
Travel		\$5,000	\$2,000	\$5,000	\$3,000	\$2,000	\$17,000
Overheads*		\$59,446	\$44,845	\$105,553	\$68,306	\$35,188	\$313,338
Subtotal		\$148,052	\$112,552	\$256,524	\$162,637	\$90,141	\$769,906
DOE-AF		\$6,366	\$4,840	\$11,031	\$6,993	\$3,876	\$33,106
Total Costs		\$154,418	\$117,392	\$267,555	\$169,630	\$94,017	\$803,012
SUMMARY							
				*Overheads include 16.5% Scientific Burden on Salaries & Benefits, 8.8% Procurement Burden on Purchases, 24% Site Support on Direct Costs, 21% G&A on Total Direct Costs & Burdens.			
Year 1	\$271,810						
Year 2	\$267,555						
Year 3	\$263,647						
Total Costs	\$803,012						

NONDISCRIMINATION COMPLIANCE STATEMENT

COMPANY NAME

ERNEST ORLANDO LAWRENCE BERKELEY NATIONAL LABORATORY

The company named above (hereinafter referred to as "prospective contractor") hereby certifies, unless specifically exempted, compliance with Government Code Section 12990 (a-f) and California Code of Regulations, Title 2, Division 4, Chapter 5 in matters relating to reporting requirements and the development, implementation and maintenance of a Nondiscrimination Program. Prospective contractor agrees not to unlawfully discriminate, harass or allow harassment against any employee or applicant for employment because of sex, race, color, ancestry, religious creed, national origin, disability (including HIV and AIDS), medical condition (cancer), age, marital status, denial of family and medical care leave and denial of pregnancy disability leave.

CERTIFICATION

I, the official named below, hereby swear that I am duly authorized to legally bind the prospective contractor to the above described certification. I am fully aware that this certification, executed on the date and in the county below, is made under penalty of perjury under the laws of the State of California.

COLE B. CANNON

OFFICIAL'S NAME

7/28/97

DATE EXECUTED

Cole B. Cannon

EXECUTED IN THE COUNTY OF
ALAMEDA

PROSPECTIVE CONTRACTOR'S SIGNATURE

Contracts Officer

PROSPECTIVE CONTRACTOR'S TITLE

ERNEST ORLANDO LAWRENCE BERKELEY NATIONAL LABORATORY

PROSPECTIVE CONTRACTOR'S LEGAL BUSINESS NAME